Pennsylvania’s Lenticular Truss “Riveting Experience”

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Project Background

• PennDOT Engineering District 4-0
• SR 1029, Section 770 over Tunkhannock Creek, Wyoming County, Pennsylvania
• Closed in 2005 due to structural deterioration & flood impact damage
• Purpose: Re-establish a crossing of the Tunkhannock Creek at or near the existing location.
• Goals: Provide a crossing at existing location that can accommodate:
  - modern farm equipment
  - emergency vehicles
  - school busses
  - road maintenance vehicles.
Lenticular Trusses

- Named after its lens shape
- “pumpkin-seed”, “fish-belly”, “cats-eyes”, “elliptical truss”, “double bowstring” & “parabolic truss”
- Popular Example: Smithfield Street Bridge in Pittsburgh Pa
- Arch, Suspension & Truss design principles are united. Horizontal thrust and pull forces are balanced at the end posts.
- Approx. 600 built in U.S. by the Berlin Iron Bridge Company. Approx. 50 in U.S. remain today.
- Only 4 remaining in Pennsylvania
Existing SR 1029 Bridge

Historical Significance
- Built circa 1881 by Corrugated Metal Company, later known as Berlin Iron Bridge Company
- “Fine example of company’s trademark lenticular truss bridge under W.O Douglas’s 1878 patent.”
- HAER identifies special note of fabrication details for pin connection at end posts.

Bridge Features
- Wrought Iron material
- 113’-8” span length
- 14’-9” c-c truss
- Dry stacked stone abutments
- Nested roller expansion bearings
Existing SR 1029 Bridge

Deteriorated Condition

- Severely deteriorated floor system
- Damaged vertical members
- Damaged end posts
- Flood impact damage
- Other misc. damage & deterioration
Remove, Repair & Relocate

Selected Alternate

• Crane pick onto truss cradle
• Truss dismantle and inspection
• Shop repairs, replacement & paint
• Truss reassemble at Lazy Brook Park
• Spans a shallow grassy swale
• Used primarily as pedestrian bridge (allows for light emergency vehicles)
• Bridge will be owned & maintained by Tunkhannock Township
• Provide a new, modern two span bridge at previous location.
Remove, Repair & Relocate

Artistic Rendering of Initial Concept
Scope of Rehabilitation

**Truss Repairs**

- **Replace**
  - Truss Pins & Pin Bolts
  - End Posts
  - Splice Plates
  - Lower Lateral & Edge Bracing
  - Deteriorated Floorbeam Angles
  - Damaged Angles of Vertical Members
  - Missing & Deteriorated Rivets
- **Repair (Heat Straighten)**
  - Damaged eyebars (bottom chord)
  - Damaged Floorbeam Hangers
  - Damaged Diagonal Bracing
- **Rivet Requirements**
  - All shop fabricated connections
  - Field Connections are allowed to be bolted w/ “Button Head” bolts
Scope of Rehabilitation

Other Bridge Elements

• Replace Missing Ornamental Features
  ➢ Bridge Plaque
  ➢ Pin Caps
  ➢ Decorative End Post Caps
• New Timber Stringers & Deck
• New Timber Pedestrian Railing
• New Concrete Abutments with Stone Veneer *(from existing abutments)*
• Create Interpretive Panel at Lazy Brook Park
Bolts vs. Rivets

**Tension Control (TC) Bolt – ASTMA325TC**
- Blind fastener with a domed head on 1 side, hex on other
- Developed and approved by AISC and RCSC as an approved high strength bolt for use in steel frames to ensure accurate pretension of installed bolts. (removes need for turn-of-nut inspection)

**Structural Steel Rivets – ASTMA502**
- Permanent metal fastener developed prior to advent of High Strength bolts, primary steel fastener until 1960’s
- Preinstall is a smooth steel cylinder with a domed head on one side
- Heated and “Driven/Hammered” into place forming second domed head
Bolts vs. Rivets

Aesthetics

- TC bolts commonly used when only 1 side of connection is visible and there is access to the “blind” side to operate the electric wrench.
- Rivets are finished on both sides and can be installed in almost any situation that a rivet was previously installed.

Historically Accurate

- TC Bolts are a “new” construction practice
- Rivets provide an “in-kind” replacement

Practicality

- TC Bolts are common construction practice.
- Rivet installation is a “craftsman” art form. Often requires a specialty subcontractor to complete the work.
Bolts vs. Rivets

Constructability – TC Bolts

- Existing truss members to be repaired with 2”x2”x¼” angles.
- Existing rivets and holes are ½” dia.
- Smallest TC bolt available ⅝” dia.
- TC bolts require reaming all holes
- Edge clearance and fit-up issues
- ¼” member widening ripple effects
- Impossible to “hide” all hex heads

Constructability – Hot Driven Rivets

- Replace ½” rivet with ½” rivet relieves all clearance and fitment issues
- Field rivets much more expensive than shop installed rivets
- Requires shipping to “Qualified” shop for repairs
Bolts vs. Rivets
Estimating Rivet Costs

- Contacted various riveters
  - Provided by Vern Mesler
- Quotes for rivets from $25 to $75 per rivet
- Costs are extremely project specific
  - Quantity
  - Field vs. Shop Installation
  - Travel vs. Home Shop
  - Remove and Replace or New Installation
- Use RS Means to verify costs
- Bid price for most rivets was included in lump sum
- Bid Item - Replace Deteriorated Rivets In-Kind
  - Unit of Measurement = Each
  - Estimated Quantity = 100
  - Bid Results = $50-$55 per Rivet
- Approximately 2,108 rivets total for entire project
Rivet Administrative Issues

Key Components to Address

- Contractor Qualifications
- List of Available Contractors
- Replacement Criteria
- Testing / Acceptance Criteria
- Payment Criteria

Available Resources

- PennDOT Form 409 circa 1949 – Rivet Specifications, Materials, Installation, Inspection
- Ohio Department of Highways Specifications 1969 – Installation and Acceptance Criteria
- AISC 5th edition – Rivet Installation Clearances
- AISC – Guide to Design Criteria for Bolted and Riveted Joints
- NEW!!! ODOT Historic Bridge Riveting Guidance (2014)
In Summary...

- Some projects are better suited for rivets than others
  - Historic Significance
  - Field vs. Shop Riveting
  - Aesthetic Concerns
  - Goals of the Project
- Costs are Project Specific
- Consider Size of Fasteners
  - Available sizes of Tension Controlled Bolts
  - Cost for reaming existing holes may be required
- Tool Clearances
  - Limited by existing member size (e.g. 2”x2” angle)
  - Limited by configuration of built up members
- Resources are available!
Construction Photos

Crane Lift for Removal
Construction Photos

Truss Cradle for Disassembly
Construction Photos

Containment and Blasting
Construction Photos

Next Steps

- Full Disassembly (Late Fall 2015)
- Inspection for Unforeseen Damage
- Fabrication (Through Winter)
- Reassembly (Spring/Summer 2016)